EFFECT OF THE SAND-BLASTING OF EDGE PEELING TOOLS ON THE CUTTING FORCES AND WEAR RESISTANCE

Chafik Labidi[1], Louis-Etienne Denaud[1], Corinne Nouveau[1], Robert Collet[1] and Laurent Henry[2]

[1]ENSAM de Cluny, 20 Rue Porte de Paris, 71250 Cluny, France
[2]Ionbond Lyon, 25 Rue des Frères-Lumière, BP 143, FR-69680 Chassieu

Abstract
One of the major problems concerning tools of wood industry is nicks occurrence on the cutting edge. This phenomenon is accentuated by the small tool angle of most of the wood machining tools. The aim of this present study is to look if the geometry modifications of the cutting edge permit to decrease the weakness of tools, especially in peeling process. For this, different sand-blasted tools were tested in laboratory peeling of beech. In addition, the adhesion of CrAlN hard coating deposited on a modified cutting edge was also explored. The results obtained showed that the artificial wear by sand-blasting permits to increase the shocks resistance, coatings anchoring and changes the wear mechanism of the tools.

1 INTRODUCTION

Previous studies showed the efficiency of surface treatments such as hard coatings obtained by PVD methods (nitriding, TiN, CrN, duplex treatments) against wear in wood machining and especially in peeling [1-2]. Nevertheless, the limitation to the production and commercialization of modified tools in wood industry is the low adhesion of the coatings on the cutting edge. Besides, the low cutting angle (19°-22°) is also a problem and responsible for a main lapping of the tool which is determinant for its service life.

In the peeling process, two cases may happen: firstly, when the dimensions of the kinks are small (no more than 200μm in depth), the operator must intervene with pumice in order to sharp the area damaged and then the production can be continued. Secondly, if the edge is totally broken (size of nicks exceed 1mm in depth), the change of tool is realized. These stops, if repeated, induce important economic losses and hard work conditions of the operators.

The aim of this present study is to look if the geometry modifications of the cutting edge permits to decrease the weakness of tools without accelerating their abrasive wear. In addition, the adhesion of CrAlN hard coating deposited on the modified cutting edge was also explored. Different sand-blasted tools were tested in laboratory peeling of beech. Optical observations, cutting forces and wear measurements were carried out to quantify the behaviour of tools.

2 MATERIALS AND METHODS

The well known [3-4] sand blasting operations were realized on a commercial sand-blast machine from IONBOND. To highlight the effect of the various rounds-offs of edges on the performances in machining, four tools were sand-blasted: two during a cycle (20s of sand-blasting) and two others during two cycles (40's of sand-blasting). Thus, one of the tools was covered with CrAlN thin film under optimal conditions [5] and the other was used without coating. The names of the tools as well as the treatments undergone are summarized in the table 1. These tools were used thereafter in micropeeling of beech under conditions defined during previous studies [2]. A method to simulate the knots was also used [5]. Optical observations, cutting forces and wear measurements were carried out to quantify the behaviour of tools.

Table 1. Tools tested

Names	Sand-blasting duration (number of cycle)	CrAlN film
Untreated	0	No
Sand-blasted 1	1 (20s)	No
Sand-blasted 2	2 (40s)	No
Covered 1	1 (20s)	Yes
Covered 2	2 (40s)	Yes

3 RESULTS AND DISCUSSION

After the shocks tests, the aspect of the cutting edges of the tools was observed thanks to SEM (Fig. 1). The tests were realised on the untreated and the sand-blasted 1 tools, on the basis of the principle that if this knife resists well against shocks in comparison with the untreated tool, the sand-blasted 2 could be only also resistant, thanks to a more important round-off of the edge. The observations reveal that the sand-blasting of tools increase its resistance against shocks. The untreated tool have cutting edge crushed while the sand-blasted one presents a regular aspect.

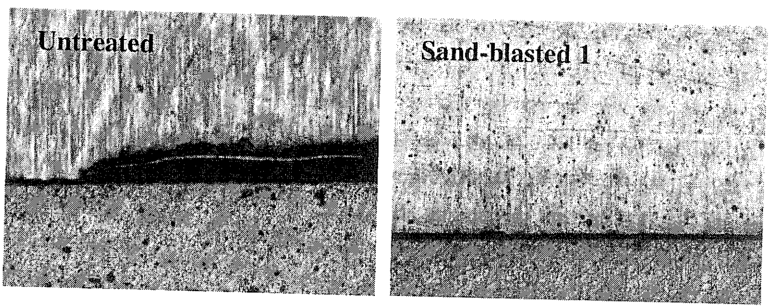

Fig. 1 Cutting edges of the untreated and sand-blasted 1 tools after shock test

For the measurement of the cutting forces, a system PULSATES (7537A B&K) was used. The component Yc of the total cutting force is strongly influenced by the initial state of the cutting edge of the tool (round-off of edge) and of the clearance angle (especially negative clearance angles) whereas the component Xc is influenced by the section of produced veneer (depth of cut). For these reasons we were interested particularly in the analysis of the component Yc of cutting force of the different tools tested. The measurement was taken during the first laps of micropeeling. The total distance of cut was 3000 m.

After 250 m (Fig. 2), the untreated tool has a cut aptitude more important than the other tools. This behaviour was somewhat expected thanks to the acuity of its edge (weak round-off of edge compared with those obtained after sand-blasting or/and coating). After coating, the round-off of edge of the covered tools 1 and 2 becomes more important than that before deposition, which explains the main aptitude for the cut of the sand-blasted 2 tool compared to the covered tools 1 and 2. At the end of the machining, the untreated and sand-blasted 1 tools tend to a refusal of cut (negative efforts) whereas the tools covered, and sand-blasted 2 seem stable (positive efforts). The behaviour of these two tools, having a weak round-off of edge compared with the other, contradicts our expectation. The difference of the measured values is however not important, and the beginning or/and the end of the micropeeling is not representative of the behaviour of the tools on the whole of the test. The curves indicate that the increasing of the round-off cutting edges of the tools (artificial wear) confer to them a better aptitude to machine. Another report also emanates from these curves. Indeed, to cover the tools after their sand-blasting procure stability and a main capacity of cut.

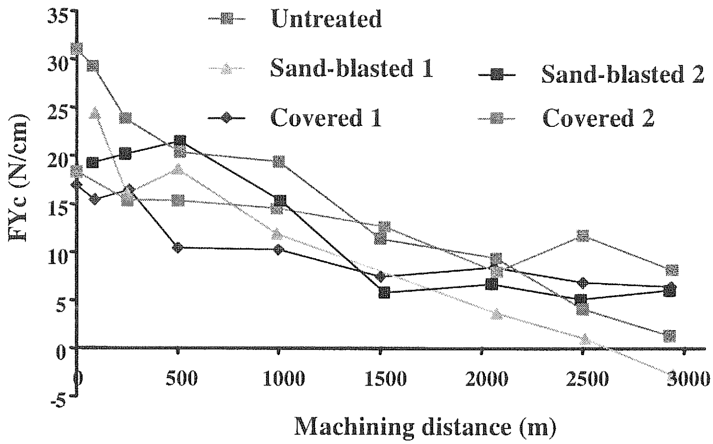

Fig. 2 Yc of the tools tested versus the micropeeling length

Parallel to the efforts measurement, we also carried out measurements of the edge recession (wear) of tools (Fig. 3). The results obtained are in adequacy with those obtained with the efforts measurements.

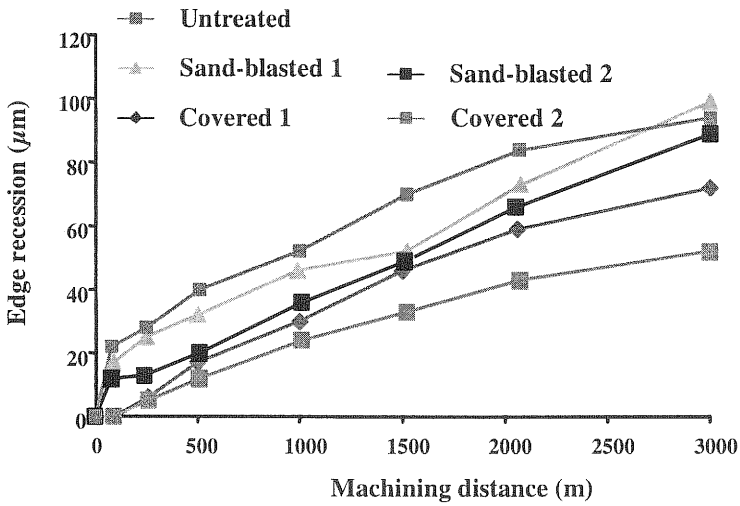

Fig. 3 Edge recession of tools tested versus machining distance

Indeed, the untreated tool has the most important edge recession values, slightly higher than those measured for the sand-blasted 1 tool. After 2800 m of micropeeling, these two curves are similar, and at 3000 m the wear value of the sand-blasted 1 tool is appreciably higher than that the untreated one. At the end of the micropeeling, the sand-blasted 2 tool presents values of wear close to those of the untreated and sand-blasted 1 tools. In addition, at the end of the process, the values of edge recession of the tools covered 1 and 2 are the lowest.

What is also important to note, is that the edge's round-off influences the machining behaviour of the covered tools. The tool covered 2 has an edge round-off more important than that of the tool covered 1, which has a higher abrasion wear resistance.

In order to understand the behaviour of the covered tools, we realised SEM observations. On the clearance face of the tool, CrAlN shows very little retreat from the edge (15μm) and this on its total length (Fig. 4). This report was also noted concerning the observations made on the rake face.

The anchoring of the layer resulted in facilitating slips it of the chip on the two faces of the tool thus allowing a better wear resistance.

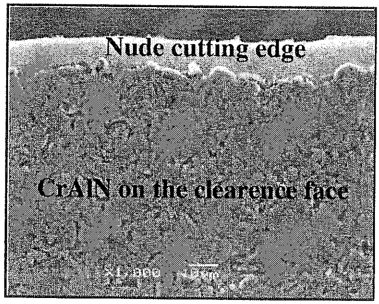

Fig. 4 Cutting edge of the tool covered 2 after 3000 m of peeling

4 CONCLUSIONS

We verified the influence of sand-blasting and duplex (sand-blasting+CrAlN PVD coating) on the wear resistance of micropeeling tools. We showed that the only sand-blasted knives performed better than the unmodified ones in terms of cut aptitude and wear resistance. In addition, the duplex treated knives performed better than the only sand-blasted ones. The best performances were shown by the duplex-2 (sand-blasted 2+CrAlN) which permits to machine more than the unmodified knife. The results obtained showed that the artificial wear by sand-blasting permits to increase the shocks resistance, coatings anchoring and completely changes the wear mechanism of tools.

5 ACKNOWLEDGEMENTS

This study has been financed by the Regional Council of Burgundy and CTBA (Wood and Furniture Technical Centre). We want to thank also IonBond France for the sand-blasting realization. Finally, we wish to thank Louis Denaud and Romaric Masset for the realization of the tests and their help.

6 REFERENCES

[1] Nouveau, C., Jorand, J., Decès-Petit, C., Labidi, C., Djouadi, M-A., "Influence of carbide substrates on tribological properties of chromium and chromium nitride coatings: application to wood machining", *Wear* 258(1-4) (2005) 157-16

[2] Labidi, C., Collet, R., Nouveau, C., Beer, P., Nicosia, S., Djouadi, M-A., "Surface treatments of tools used in industrial wood machining", *Surface and Coatings Technology* 200(1-4) (2005) 118-122

[3] Klocke, F., Krieg, T., "Coated tools for metal cutting-Features and applications", *Annals of the CIRP* 48(2) (1999) 1-11

[4] Tonshoff, H.K., Mohlfeld, A., Spengler, C., Podolsky, C., "PVD coated tools for metal cutting application", Actes de la conférence Internationale 'THE Coatings' (14-15 October 1999) Thessaloniki (Grèce) 1-20

[5] Labidi C., "Amélioration de la durée de services des outils d'usinage du bois par traitements de surface et préparation de l'arête de coupe", Thèse de doctorat N°58-2006, ENSAM de Cluny